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Measurement of Dynamic Surface Deformation of Liquid Bridge with Thermocapillary Convection by Using Temporal Speckle Pattern Interferometry

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Abstract

This paper presents a technique for measuring two-dimensional dynamic surface deformation (DSD) of liquid bridge with thermocapillary convection by using temporal speckle pattern interferometry (TSPI). The technique includes two parts; one is the determination of multiple reference phases from phase-shifted speckle images and the other is the recovery of DSD-induced phase variations from sequential specklegrams that are correlated with the reference phases. The reference phases are determined by using a temporal speckle phase method (TSPM) incorporating a piezoelectric translator. On the other hand, the phase variations are recovered by using a new algorithm that is modified from the method proposed by Carlsson & Wei (2000). It utilizes neighboring pixel information to calculate the phase change from a pre-determined initial phase to be determined separately. The present modification is done by replacing the use of a single initial phase with that of multiple reference phases so as to minimize the effect of errors in the initial phase as well as in the specklegrams acquired. The present method is shown to be effective for dealing with both large noise in specklegram and error in initial phase. Its performance is verified through both computer simulations and direct comparisons with the data obtained using a different method. The DSD results measured in pulsating mode and in rotating mode in oscillatory thermocapillary convection are reported here. Some new features, such as the propagation direction of DSD wave, are detected in the first from the present measurement.